APPENDIX C

SEISMIC SURVEY REPORT

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Letter Report on a Seismic Refraction Survey conducted at the Schwerin Concaves Site near Walla Walla, Washington, for Mr. Bill Fees, Washington Dept. of Ecology, Spokane Regional Office under WDOE Field Order Number PF 286901 on January 29, 2002

Introduction

Aquila Geosciences performed a seismic refraction survey at the Schwerin Concaves site near Walla Walla, Washington, on January 29, 2002. The purpose of the survey was to determine the depth to bedrock profiles at various locations around the site.

Method of Investigation

The field work for this survey was done on January 29, 2002. Mr. Bill Fees and Ms. Sandy Treccani of the Washington Department of Ecology assisted in the field, including specifying line locations and orientations, and swinging the sledge hammer.

Five seismic refraction lines were acquired at this site. Two of these lines (2 and 4) were 460 feet long and oriented East-West. Two were oriented North-South, with line 1 being 460 feet long and line 5 is 220 feet long. Line 3 was a 220 foot long line oriented Southeast-Northwest. Figure 6 is a sketch map showing the line locations.

The data were acquired using a Geometrics S-24 Engineering Seismograph. Receivers were Geospace 10 Hz. vertical component geophones set at 20 foot spacings. The energy source was a 12-pound sledge hammer beaten against an aluminum plate. Data acquisition was done in a manner so that the data could be processed using the Generalized Reciprocal Method (GRM) of Palmer (1980). The "far" offset shots were acquired at locations that assured that first arrivals from the basalt bedrock target were received on all geophones on each line. Winter weather conditions combined with the depth of the target made data acquisition very slow.

Data Quality

The data collected for this survey varied in quality from good to poor, the result of frozen ground and noise. Frozen ground is one of the major problems with acquiring seismic data during the winter. Even with pilot holes punched for the geophone spikes, the "couple" (connection) between the geophones and the ground is poor, because it is not possible to get a significant part of the geophone case in contact with the ground. The received signals are weaker, and the geophones are much more susceptible to noise, especially noise carried through the air. The principal sources of noise at this site were work being done by employees at the site, some traffic noise, and wind noise. Noise was never bad enough to require filtering the data.

Data Processing and Interpretation

The seismic data were processed with both in-house software and Viewseis® software which uses the Generalized Reciprocal Method (GRM). All five lines were interpreted as three (3) layer cases. Intercept velocities were used for the first two layers, while the GRM velocity function was used to determine the velocity of the basalt.

Discussion

Figure 6 is a sketch map showing the locations of the seismic lines and the monitoring wells at the site. Figures 1 through 5 show the depth profiles for lines 1 through 5, respectively. The tables provide the depth to bedrock and velocity information in tabular form. **Please note that because we have no ground surface elevation data for these lines the ground surface appears flat. The bedrock topography represents a combination of the variations in the actual bedrock topography <u>plus</u> variations in ground surface elevation.**

As stated above, the subsurface was treated as a three-layer case for processing and interpretation purposes. The first layer is low velocity soil, with seismic velocities ranging from about 850 ft/sec to about 1,220 ft/sec. The second layer appears to correspond to the clayey to sandy gravel reported in the monitoring well logs. The seismic velocity of this layer ranges from a low of about 1,850 ft/sec to a high of about 4,900 ft/sec. The general range is between 2,500 ft/sec and 4,500 ft/sec. The third layer is interpreted to be the basalt bedrock. The velocity of this layer ranges from a low of about 5,450 ft/sec to a high of about 9,720 ft/sec. The low velocity occurs only at the southern end of line 5, the velocity for this layer is greater than 8,000 ft/sec everywhere else.

Calculated depths to basalt range from a minimum of about 21 feet below ground surface (bgs), near the East end of line 2, to a maximum of about 70 feet bgs, at station 03+40 on line 1. The general shape of the bedrock surface suggests that the basalt has a channel in it that enters from the east or northeast and then crosses the northern part of line 5 and the northern part of line 1. At this point the channel appears to turn toward the northwest and crosses line 4 between lines 1 and 3. This is shown in figure 7, which is a map of the interpreted depth to bedrock within the area of the seismic survey.

We wish to emphasize that the depths shown in the tables should be compared to the depth profiles for each line. The seismic refraction method we use determines the <u>distance</u> from the geophone to the target refractor. This is not necessarily the depth to the target refractor vertically below the geophone. Rather, this is what the arcs shown on the profiles represent. The actual profile of the refractor surface is best represented by a curve drawn tangent to these arcs. In areas where bedrock topography is relatively steep it is quite possible for bedrock to be deeper directly below the geophone than the "depth" (distance from the geophone) calculated by the method. This can be seen in the profiles. In areas where dips are relatively low the difference is not great.

Conclusions and Recommendations

The seismic refraction survey performed at the Schwerin Concaves site was able to determine depth to basalt "bedrock" along all five of the seismic lines surveyed. Ties to existing monitoring wells are good and depths at line crossings match within expected error. Should further delineation of the bedrock surface be required, the seismic refraction technique is a viable method for this site.

The results of this survey are intended for use in project planning and management. We consider data derived from geophysical surveys as useful for supplementing and augmenting observations made by direct sampling techniques such as drilling or trenching. The geophysical surveys we do are intended to guide direct sampling, not replace it. Surveys are designed based on information known about the survey area prior to conducting the survey. All interpretations are opinions based on inferences from electrical measurements and the accuracy or correctness of such interpretations cannot be guaranteed.

Please feel free to call should you have any questions.

Sincerely,

Kent R. Johnson

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Geologist/Geophysicist

attachments: 7 figures
5 tables